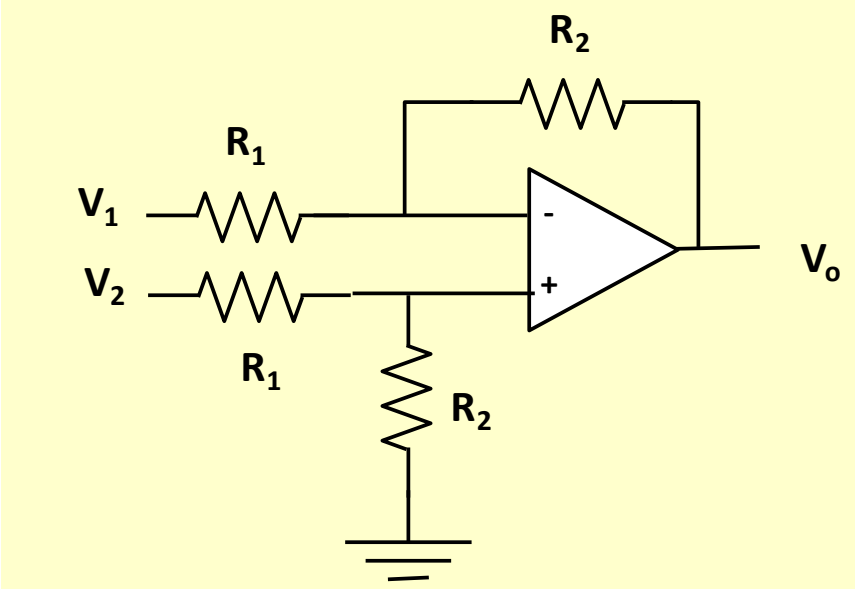
Amplificador diferencial



ANÁLISIS

- Cortocircuito virtual:v+ = v -
- Principio de superposición

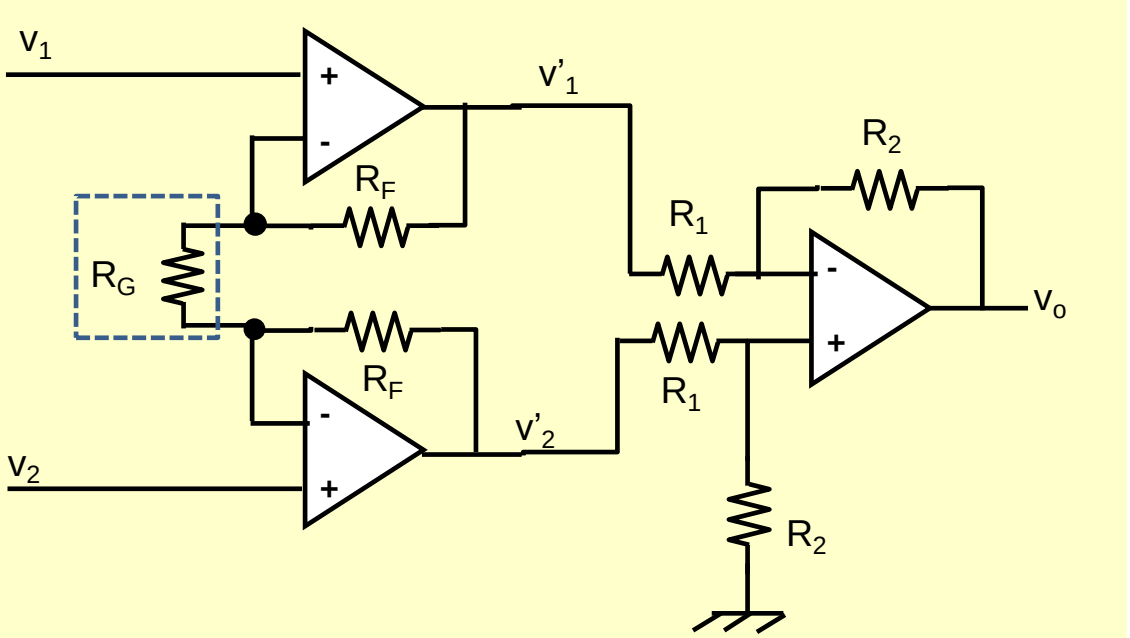
$$v_o = v_o\big|_{v1} + v_o\big|_{v2}$$

$$v_o\big|_{v1} = -\frac{R_2}{R_1} v_1$$

$$v_o\big|_{v2} = \left(1 + \frac{R_2}{R_1}\right) \cdot \frac{R_2}{R_1 + R_2} \cdot v_2 = \frac{R_2}{R_1} \cdot v_2$$

$$v_o = \frac{R_2}{R_1}\left(v_2 - v_1\right)$$

Amplificador de instrumentación



ANÁLISIS

$$v'_1 - v'_2 = v(R_F) + v(R_G) + v(R_F)$$

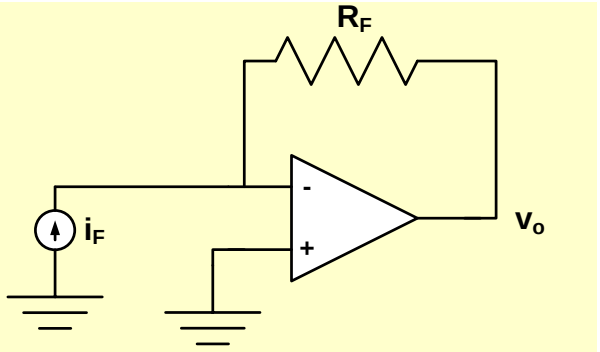
$$\Rightarrow v'_1 - v'_2 = \frac{v_1 - v_2}{R_G} \cdot \left(R_F + R_G + R_F\right)$$

$$\left.\begin{aligned} v'_2 - v'_1 &= \left(1 + \frac{2R_F}{R_G}\right) \cdot (v_2 - v_1) \\ v_o &= \frac{R_2}{R_1}\left(v'_2 - v'_1\right) \end{aligned}\right\} \Rightarrow \boxed{v_o = \frac{R_2}{R_1} \cdot \left(1 + \frac{2R_F}{R_G}\right) \cdot (v_2 - v_1)}$$

Amplificadores de instrumentación integrados (ej: AD620)

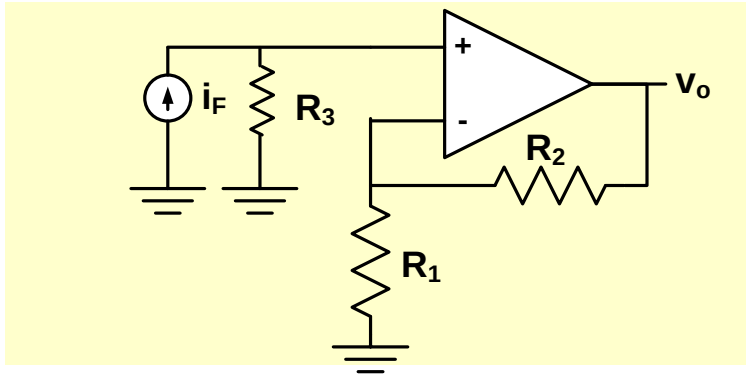
Conversor corriente-tensión (Amplificador de transimpedancia)

INVERSOR



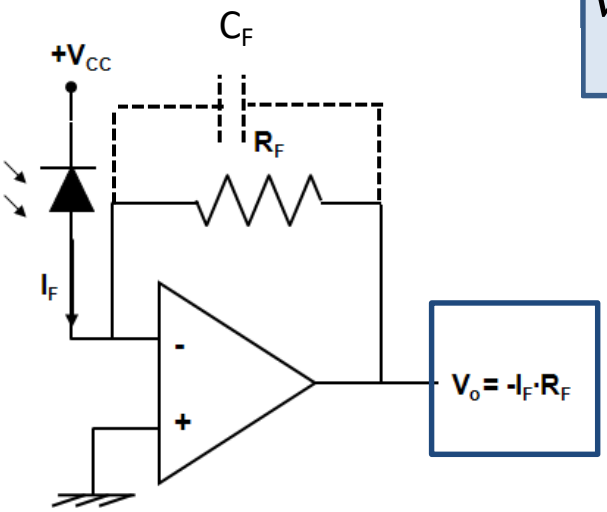
$$v_o = -R_F \cdot i_F$$

NO INVERSOR



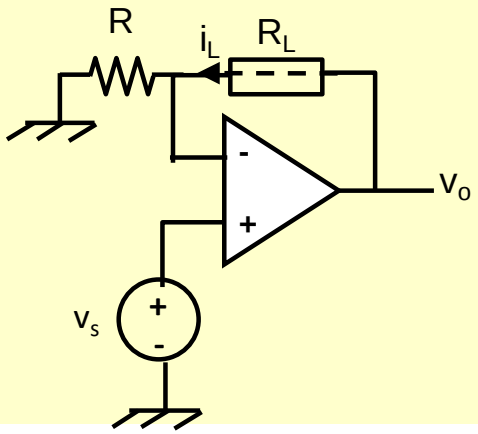
$$v_o = R_3 \cdot \left(1 + \frac{R_2}{R_1}\right) \cdot i_F$$

Circuito acondicionamiento fotodiodo



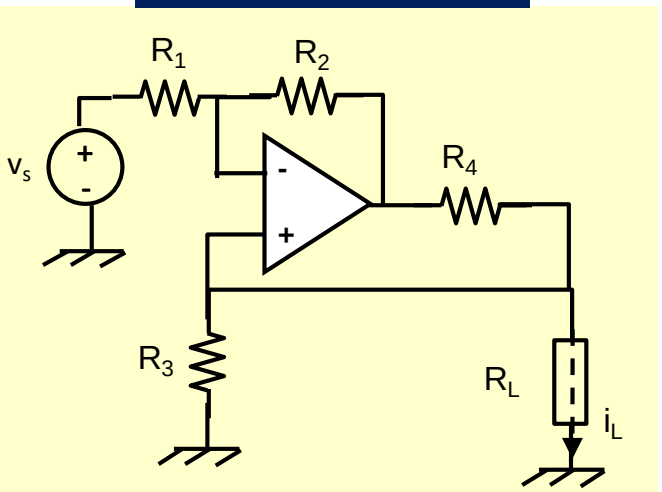
Conversor tensión-corriente (Amplificador de transadmitancia)

CARGA FLOTANTE



$$i_L = -\frac{v_s}{R}$$

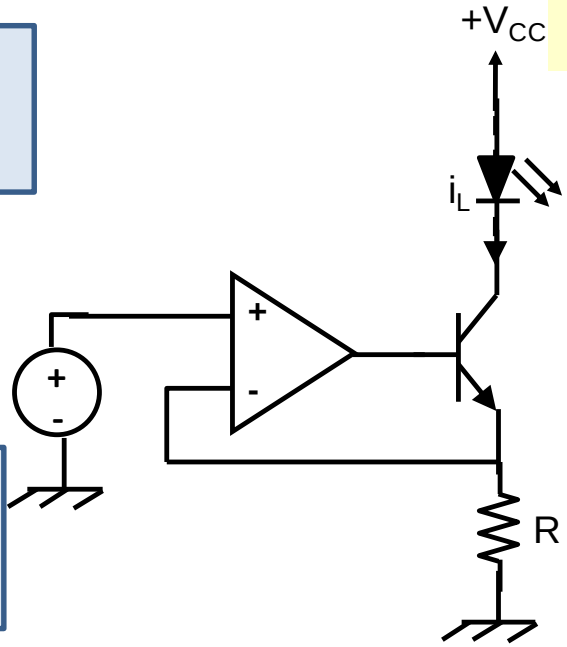
CARGA A TIERRA



$$\frac{R_2}{R_1} = \frac{R_4}{R_3}$$

$$i_L = -\frac{v_s}{R_3}$$

Driver LED



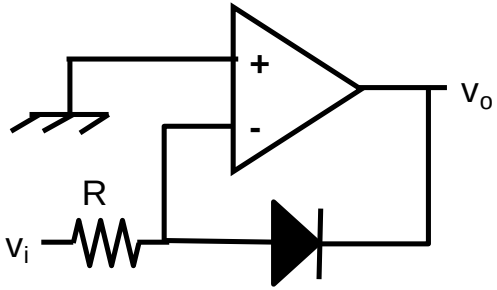
$$i_L = \frac{v_s}{R}$$

Amplificador operacional ideal: aplicaciones no lineales

- Amplificador logarítmico y antilogarítmico
- Rectificadores de precisión
- Comparador
- Disparador de Schmitt (comparador con histéresis)
- Oscilador de relajación

Amplificador logarítmico y antilogarítmico (exponencial)

LOGARÍTMICO

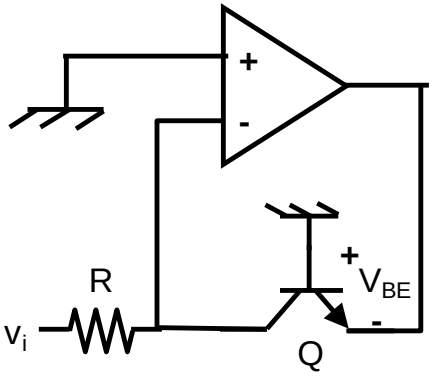


$$i_D = i_R = \frac{v_i}{R}$$

$$v_o = -v_D = -V_T \cdot \ln\left(\frac{i_D}{I_s}\right)$$

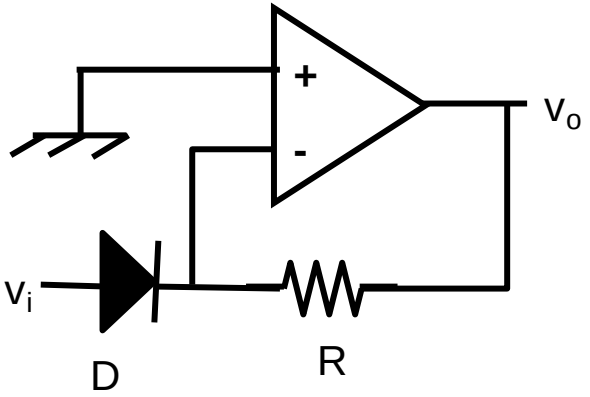
D

$$\Rightarrow v_o = -V_T \cdot \ln\left(\frac{v_i}{R \cdot I_s}\right)$$



$$v_o = -V_T \cdot \ln\left(\frac{v_i}{R \cdot I_{CO}}\right)$$

EXPONENCIAL

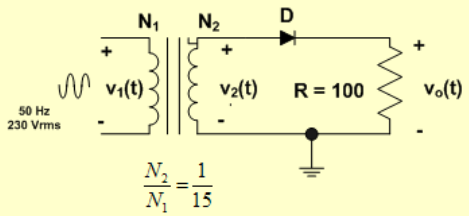


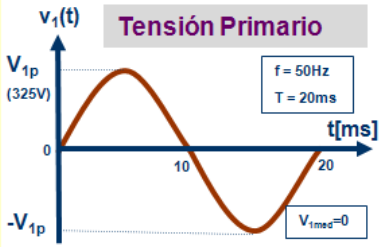
$$i_R = i_D = I_s \cdot \exp\left(\frac{v_D}{V_T}\right) = I_s \cdot \exp\left(\frac{v_i}{V_T}\right)$$

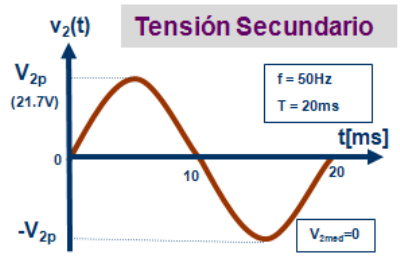
$$v_o = -R \cdot i_R$$

$$\Rightarrow v_o = -R \cdot I_s \cdot \exp\left(\frac{v_i}{V_T}\right)$$

Rectificador de media onda

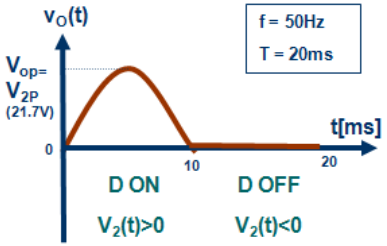






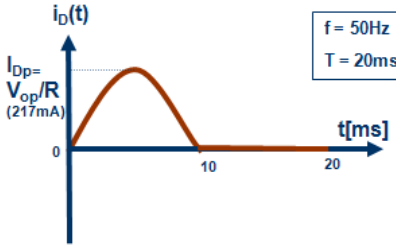
1ª Aproximación (Diodo ideal)

Tensión Salida

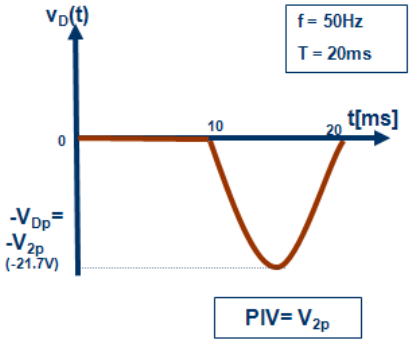


$$\overline{v_o} = \frac{V_{op}}{\pi}$$

Corriente Diodo

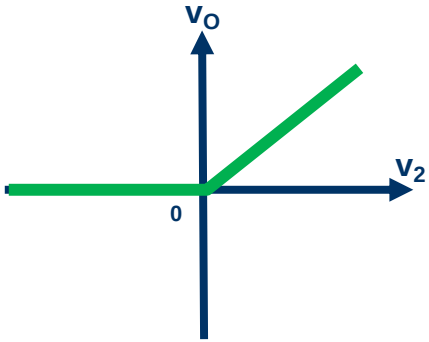


Tensión Diodo

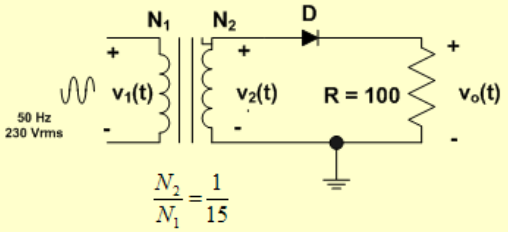


PIV= V_{2p}

Función de transferencia

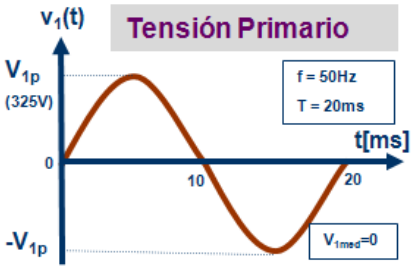


Rectificador de media onda

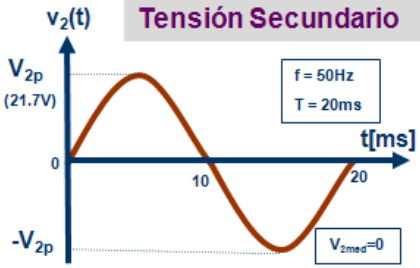


$$\frac{N_2}{N_1} = \frac{1}{15}$$

Tensión Primario

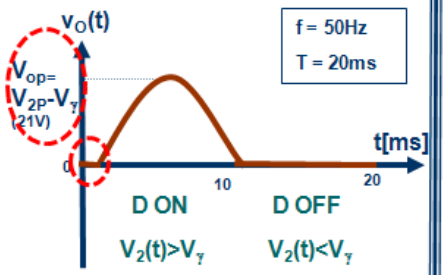


Tensión Secundario



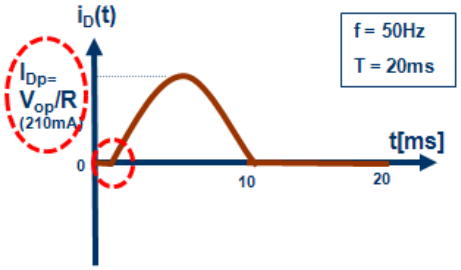
2ª Aproximación (V_γ=0.7V en directa)

Tensión Salida

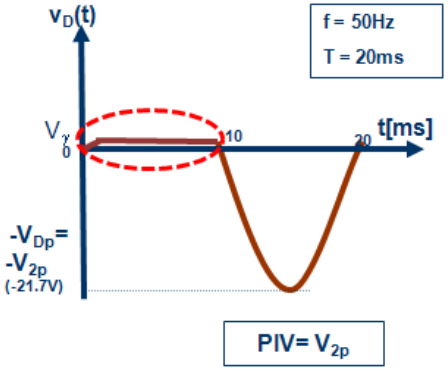


$$\overline{v_o} \approx \frac{V_{op}}{\pi}$$

Corriente Diodo

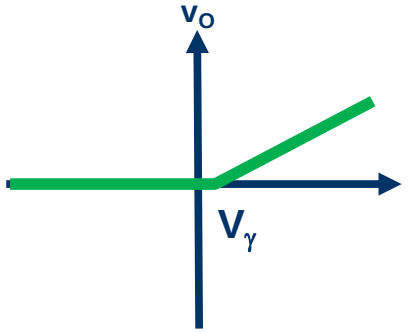


Tensión Diodo

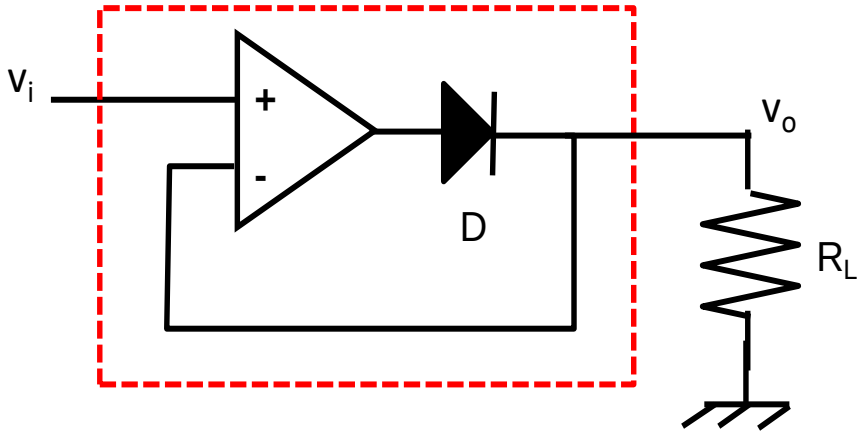


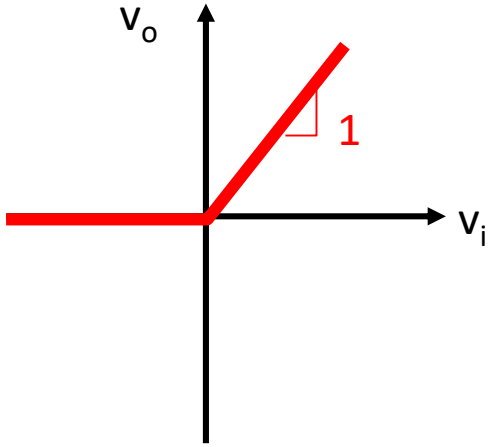
PIV= V_{2p}

Función de transferencia

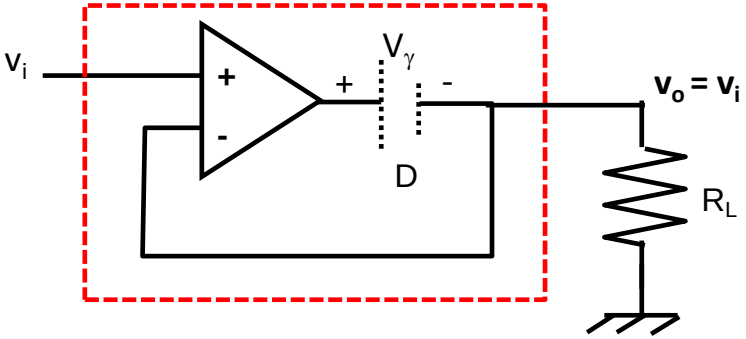


Rectificadores de precisión

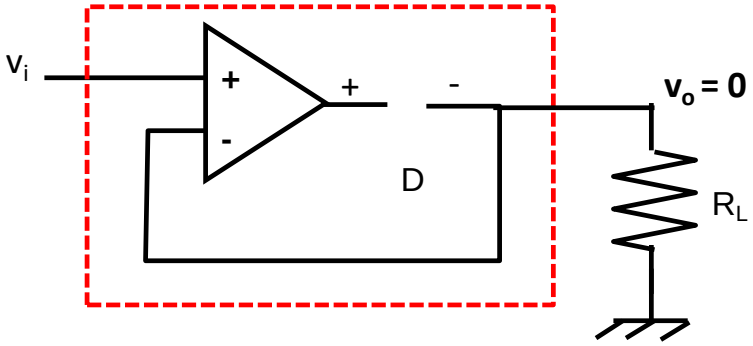




D ON



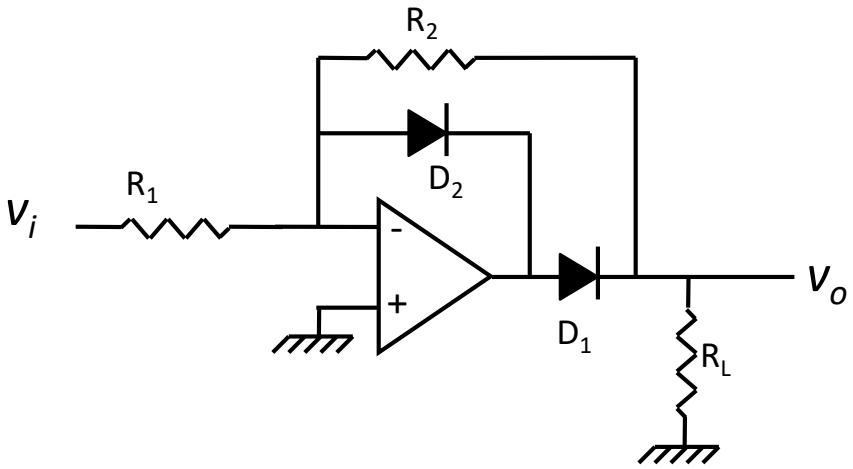
D OFF

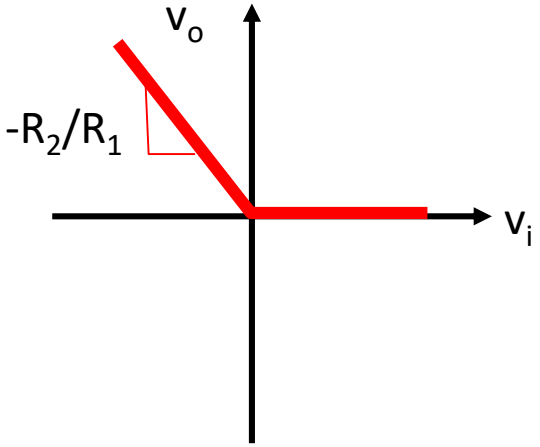


$$A_{vdAO} \cdot v_i > V_\gamma \Rightarrow v_i > \frac{V_\gamma}{A_{vdAO}} (\cong 0)$$

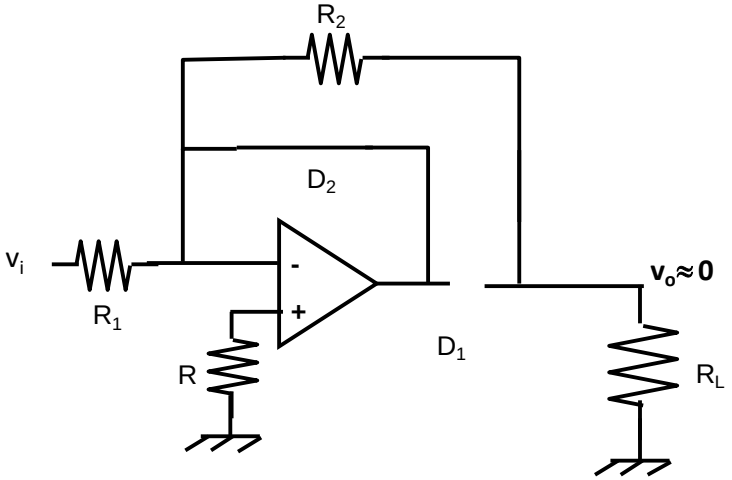
$$A_{vdAO} \cdot v_i < V_\gamma \Rightarrow v_i < \frac{V_\gamma}{A_{vdAO}} (\cong 0)$$

Rectificadores de precisión

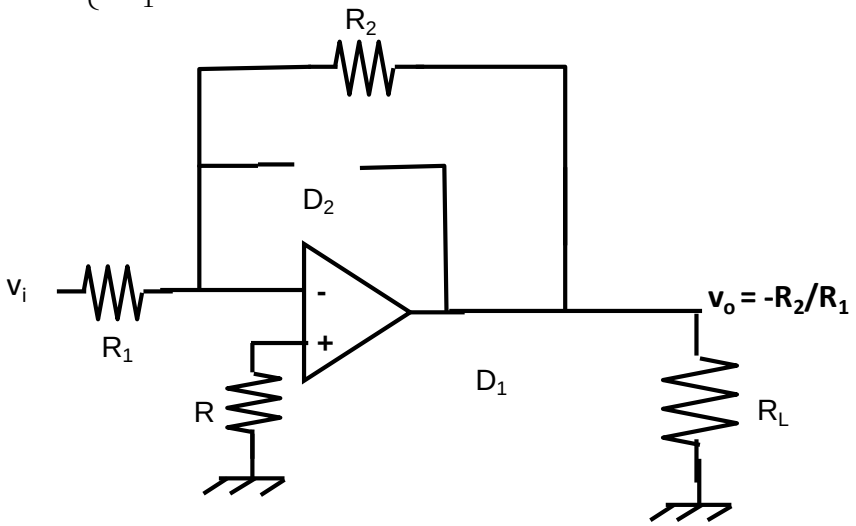




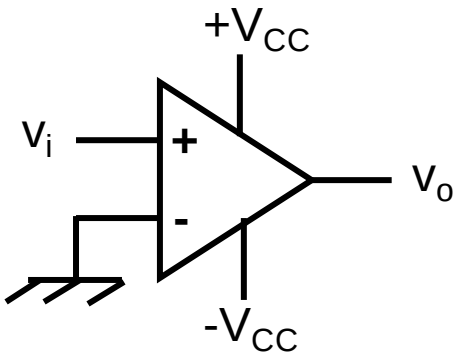
$$v_i > 0 \Rightarrow \begin{cases} D_2 & ON \\ D_1 & OFF \end{cases}$$

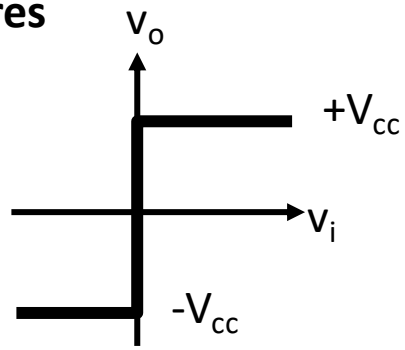


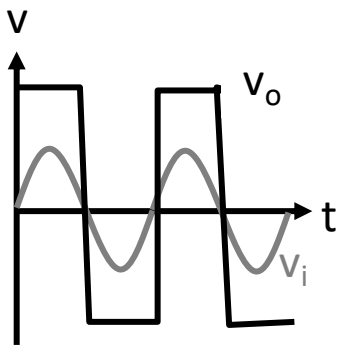
$$v_i < 0 \Rightarrow \begin{cases} D_2 & OFF \\ D_1 & ON \end{cases}$$

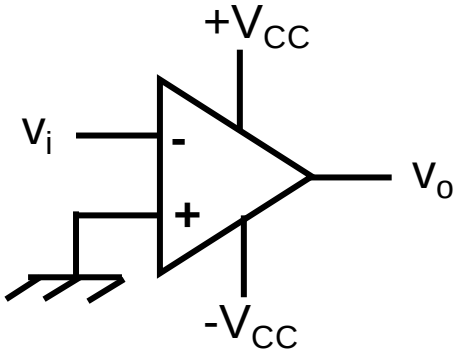


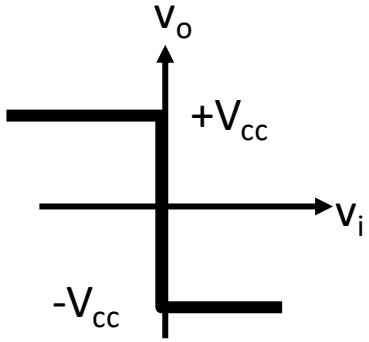
Comparadores

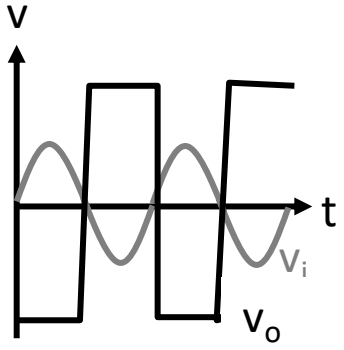


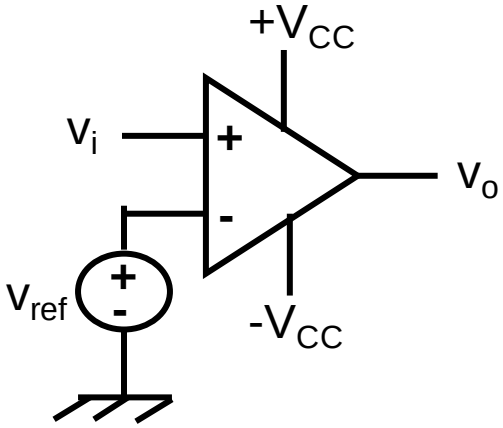


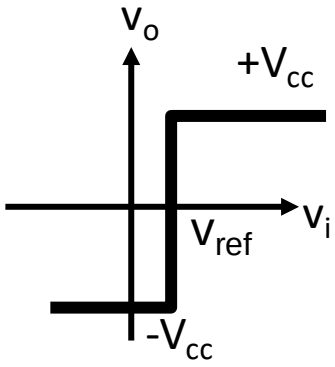


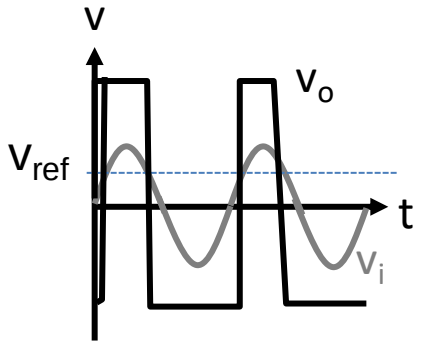






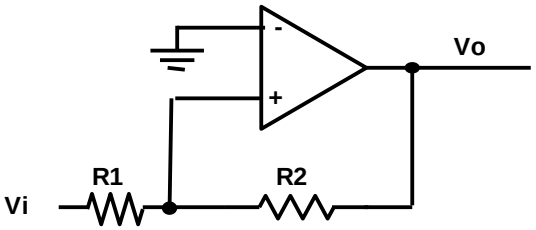




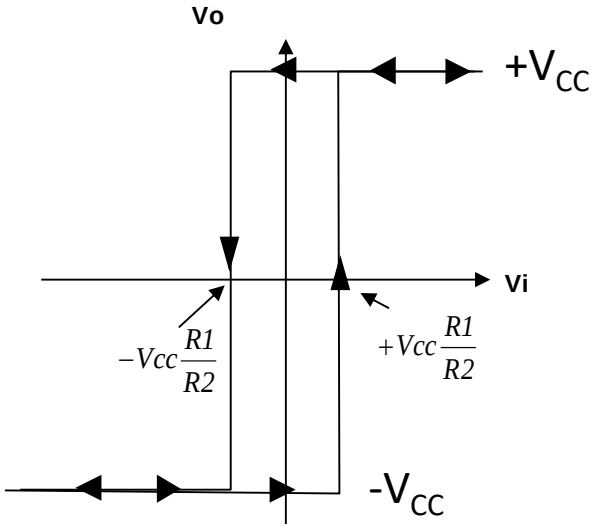


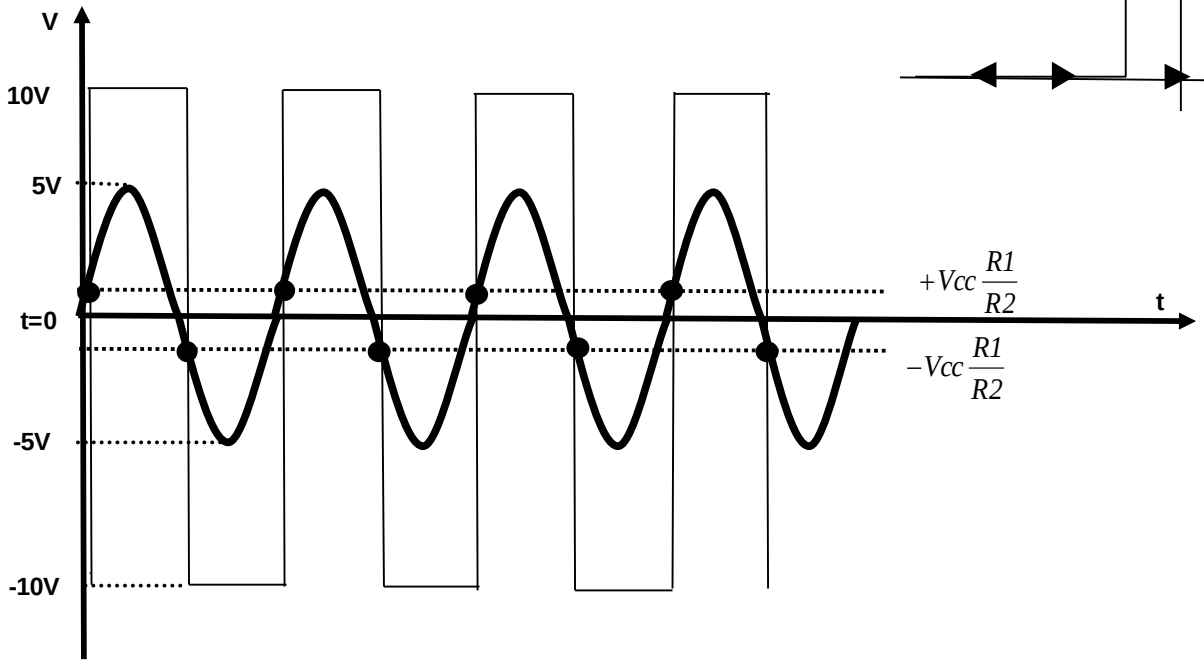
Disparador de Schmitt

Comparador con histéresis no inversor



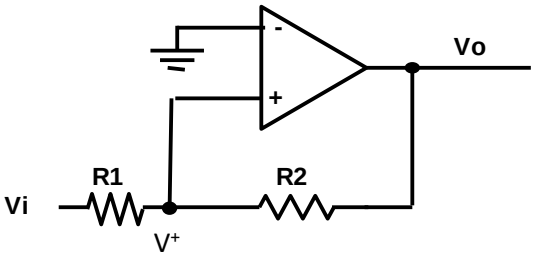
Función de transferencia





Disparador de Schmitt

Comparador con histéresis no inversor



$$v^+ = v_o \cdot \frac{R_1}{R_1 + R2} + v_i \cdot \frac{R_2}{R_1 + R2}$$

$$v^+ = \pm V_{cc} \cdot \frac{R_1}{R_1 + R2} + v_i \cdot \frac{R_2}{R_1 + R2}$$

Si $v_o = +V_{cc}$

Se produce la comparación cuando se cumple que v^+ pasa ser menor que cero:

$$0 \geq +V_{cc} \cdot \frac{R_1}{R_1 + R_2} + v_i \cdot \frac{R_2}{R_1 + R_2} \Rightarrow v_i \leq -V_{cc} \cdot \frac{R_1}{R_2}$$

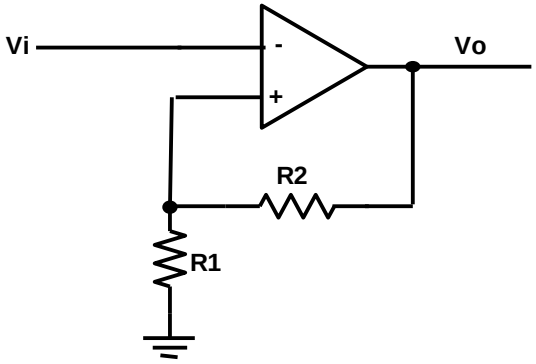
Si $v_o = -V_{cc}$

Se produce la comparación cuando se cumple que v^+ pasa ser mayor que cero:

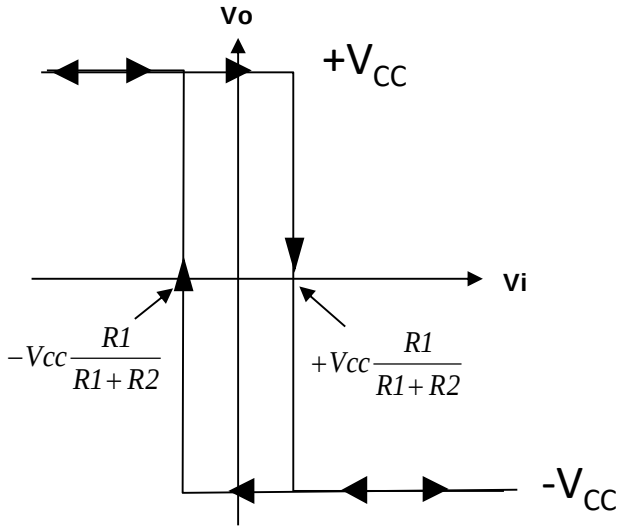
$$0 \leq -V_{cc} \cdot \frac{R_1}{R_1 + R_2} + v_i \cdot \frac{R_2}{R_1 + R_2} \Rightarrow v_i \geq +V_{cc} \cdot \frac{R_1}{R_2}$$

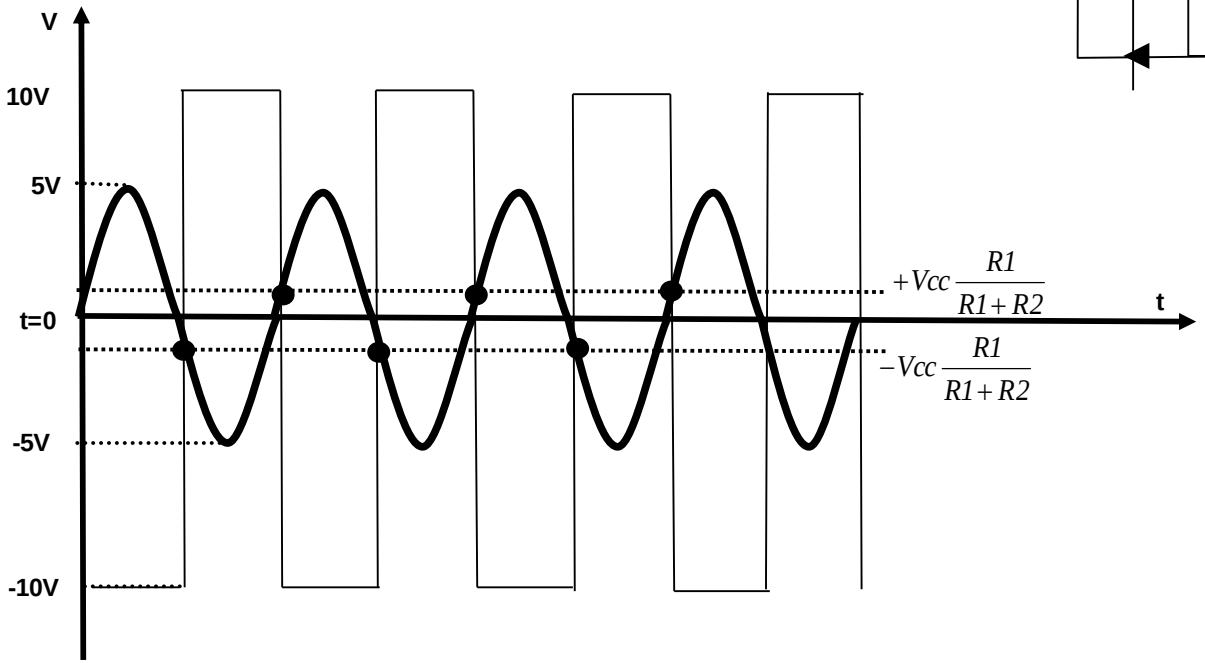
Disparador de Schmitt

Comparador con histéresis inversor

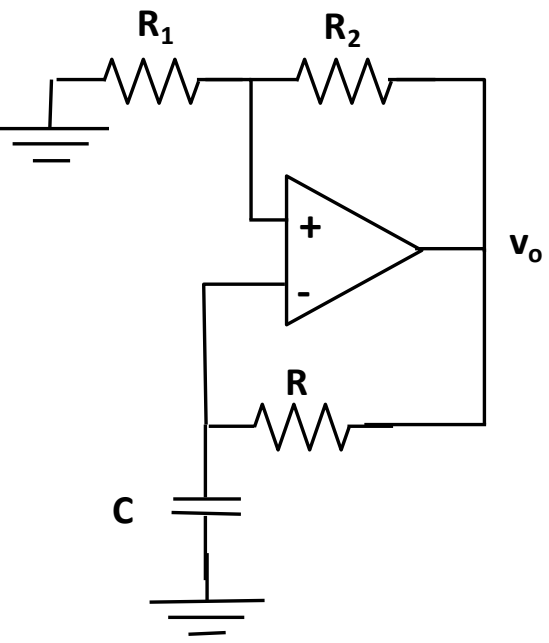


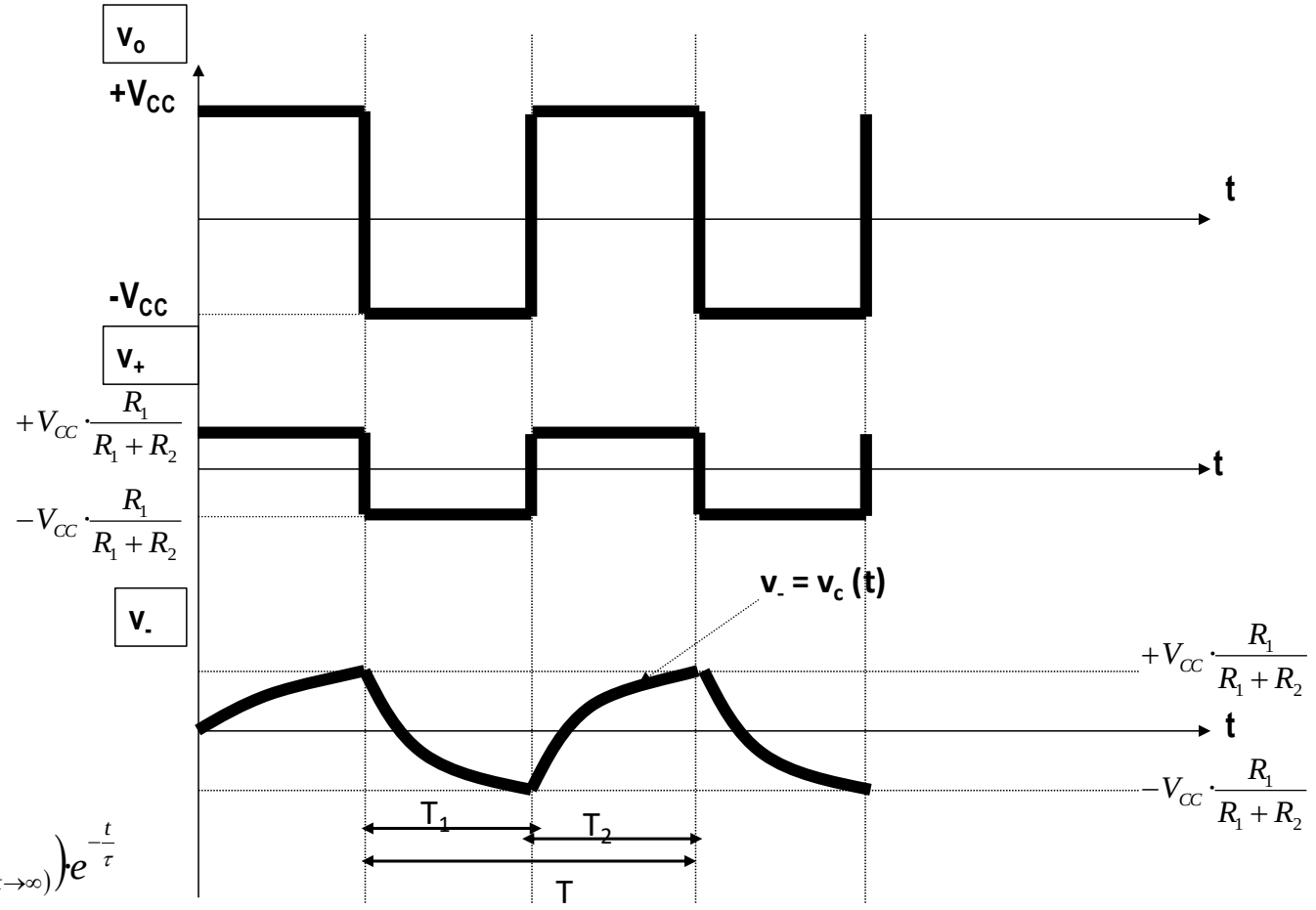
Función de transferencia





Oscilador de relajación





$$v_{-} = v_C(t) = v_{-(t\to\infty)} + \left(v_{-(t=0)} - v_{-(t\to\infty)}\right)\cdot e^{-\frac{t}{\tau}}$$

$$v_{-}(T_2) = +V_{CC} + \left(-V_{CC}\cdot\frac{R_1}{R_1+R_2} - (+V_{CC})\right)\cdot e^{-\frac{T_2}{RC}} = +V_{CC}\cdot\frac{R_1}{R_1+R_2} \Rightarrow T_2 = RC\cdot\ln\left(\frac{2R_1+R_2}{R_2}\right) = T_1$$

$$T = 2RC\cdot\ln\left(\frac{2R_1+R_2}{R_2}\right)$$